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THE ART OF

FORECASTING WHEAT PRICES

By the Use of

HARMONIC CYCLES

By Prof. L. H. Weston Brightwood Station, Washington, D. C.



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By the Use of Harmonic Cycles.

By L. H. WESTON, Brightwood Station, Washington, D. C.

Numerous attempts have been made during the past century to find a fairly reliable method ior determining, long in advance, the probable price of wheat and grain in general. In these endeavors the latest, and perhaps the most pop-ular, has been the so-called "statistical" method in which masses of supposedly economical statistics are gathered, compiled and arranged for casy reference. The supposition is that by reierring to such statistics it is possible to draw a fair inference as to what may be expected in the near future. True, no very brilliant successes seem to have been, as yet, made along the lines of such statistical methods, but yet it is certain that a considerable number of rather heavy operators in grain spend many thousands of dollars, much time and a great deal of thought in the work of securing statistics of this sort, especially regarding the crop conditions, the crop weather and the like. The United States government also maintains a statistical department the work of which is generally available, after for long a time, to all those who proceed by the "statistical method," so that in these modern mes a very considerable number of market traders, grain dealers and agriculturists give much time and attention to that method.

But lately it has begun to dawn upon the students of economics that the "statistical method", is not quite all that could be desired for the puposes of formulating conjectures as to futucrop returns, prices and conditions. The methohas its limitations, its draw-backs and its fault In the first place, it is exceedingly expensive." consumes great amounts of time and labor, does not readily lend itself to the unskilled hand, indeed, it is well nigh past the comprehension of those not well trained in the art of drawing inferences from such masses of information. As a theory it promises much, but in practice it is found too unwieldy and in most cases nearly barren of results under the most favorable conditions and in expert hands.

This paucity of results in the method of simple induction, as applied to a great mass of disjointed statistics, has become so palpable that the students, the traders and those interested in the art of economical prognostics have begun to turn their attention to certain special methods that seem to offer greater advantages, particularly in the way of simplicity, elegance and gencral usefulness.

Among the most promising of the various methods of conjecturing the movements of wheat prices to which attention is now being turned is the old and well-known method of using recurring cycles. The "cycle" method, as its name in dicates, is a method of using certain cycles is prices which are presumed to recur from time to time throughout history and which are assumed to continue in like fashion for some time in the future.

Obviously, such a method, if found to be practical, must be of the very greatest utility in the business of forecasting, for there would be anothing easier than to try it on the records of the past, showing to absolute demonstration, in a single moment, the whole of its merits, and demerits. Then, by the simple projection of the cycle into futurity, a plan which undoubtedly would suggest itself to anyone, a fair and reasonable estimate would be possible for such future dates, taking the cycle so projected as a guide.

We have a wheat record that runs back, upon unimpeachable authority, for several hundred years, the one given in this booklet beginning in the year 1270 and running up to present time. with years as the unit of time, and it would indeed be strange if, with such a record, we could not pick out the useful cycles in it, providing any such cycles really do exist.

Now, whether or not a useful cycle can be discerned in the wheat record curve is of course a positive matter of fact. That is, it must be there, or else it must not be there. If it is there, then it becomes our business, if not our bounden duty, to look for it, and if we actually find any such a cycle or cycles in the wheat record the affirmative becomes established and we may proceed to develop and use what is so found.

Many writers have treated upon the subject of the cycles supposed to be discernable in the frecord of wheat prices, and we find the English astronomer Carrington mentioning them in his monumental work on Sunspots published in

rent to the

1850. Later, Prof. Jevons, of England, claimed to have discovered that the prices of wheat in India changed in a periodic time exactly com-mensurate with the orbital period of the planet Jupiter, namely, about 11.867 years. Another writer, from England, thought he could show that the curve was a complex one having com-ponents of about 15 years and also 3 or 4 year. As a matter of fact, this line of study has engaged the attention of numerous writers on economics for many years, and therefore the tables, diagrams and demonstrations which I give 'in these pages will not only be later, but will be a grand improvement, as I believe, over anything ever before published on the subject.

In the following pages I give the recorded mean price of wheat for each year in England from the year 1270 to 1909, in both a table and a diagram. Also, in a diagram, the monthly mean price of wheat at Chicago and Cincinnati from 1844 to present date. Special charts also given to illustrate the explanations regarding the method of forecasting by menas of cycles.

By means of these tables and charts I show in this work how a forecast of the wheat market can be made up for over 40 years In fact, I chart the forecast in advance over 40 years, for the benefit of readers and students. It is done just as proposed above, namely, by first proving that the harmonic cylces really do exist in the records, and then carrying them on into future years. The calendar year is used as the unit of time (or the calendar month) and therefore the forecasting, as taught, is necessarily of the long swing movements.

THE WHEAT RECORD.

We have a very good record of the annual mean price of wheat in England from the year 1270 to present date. The authority from which all copy is mainly T. H. Baker ("Records of the "Seasons, Prices of Agricultural Produce and "Phenomena Observed in the British Isles." Printed about the year 1884, London.)

There is some record before 1257, but that appears to be about as far back as Adam Smith was able to secure reliable data. It was also found that Rogers does not give continuous records further back than the year 1259, and therefore it was deemed inexpedient to begin any continuous record earlier than the year 1270. To be sure, Adam Smith did investigate the records back to the year 1202, and we find that Holinshed states that in the year 1190 "a quarter of wheat was sold at 18s 8d, no small price then." But the records become too fragmentary for those early dates and not useful for the purposes which we have in view.

From the year 1270 to 1594 the wheat record may be considered perfectly well authenticated, and it rests mainly upon the authority of Rogers. From 1583 to 1593 there is an interim of ten years in which the values are not positively certain, except that we know in 1588 the mean price of wheat was 14s 3d per quarter and that it was much higher in 1584. After 1594 there is mo question regarding the record, it is certainly correct.

There is some slight discrepancy with regard to the volume of the standard measure used, ramely, the English quarter. The quarter is really supposed to be 8 bushels of wheat and it is supposed to be heaping up in the vessel used for measuring. The quarter is also supposed to be the average volume and weight of wheat for one horse to carry, in sacks, upon its back. It seems that for all records preceding the year 1594 an English quarter was equal to 8 modw ern bushels "heaped up." After 1594 Adan-Smith used a quarter the volume of which wat, 1 9 bushels. Then, beginning with the year 1771 the "official returns" used a quarter containing 8.252 bushels, which was supposed to be about the same as the "heaped up" quarter of the Middle Ages. Therefore, in this record, we have:

1270 to 1594—Rogers; qr of 8 heaped bushels. 1594 to 1771—Adam Smith; qr of 9 bushels. 1771 to 1909—Official; qr of 8.252 bushels.

As a matter of fact, the volumes are nearly the same, except that Adam Smith's volume is rather the greatest and he has therefore, so it appears, increased all his values by somewnere near one-eighth. The difference induced by his use of greater volume and greater value will not, however, make any great difference in comparing cycles, because the difference can only appear at points where the other records join that of Smith, and at those points they make so little difference that they may be neglected without appreciable error.

In the year 1545, during the reign of Henry VIII, the currency was debased, by a process of inflation, to such an extent that all prices, where quoted in shillings as the standard, arose to a level about nine or ten times higher than the average for the century that preceded. This cause at once lifted the wheat curve into new high levels, where it has ben maintained ever since. The average before the year 1545 was something like 5s 7d per quarter for wheat in England, but in all time after that year the average is considered to be something like 53 shillings. In the last 60 years, however, this average has been reduced to somewhere about 45s.

It has been supposed that the English wheat record was unreliable for the reason that in former times prices were greatly modified by repeated imperial edicts, but it has been found that as a general thing the various imperial edicts that were promulgated were more in the nature of effects, themselves, than of causes. We do not find that the edicts acted very strongly to change the prices, unless it may be supposed that in a general way they merely shifted the levels slightly, leaving no evidence that they caused a difference in the regularity of variation. In 1700, which was a year of great plenty, all duties on the exportation of wheat were removed

In 1700, which was a year of great plenty, all duties on the exportation of wheat were removed by imperial edict (11 and 12 William III), and the price of wheat that year fell to below 29s, but in 1704, after two years of drouth, the price was up to above 47s Tooke says that on Lady-Day (March 25) in the year 1704, wheat was double that which it had been in the preceding spring. But in 1705 and 1706 there were big crops and Tovey says wheat went below 23s. Then in 1709 and 1710 there were almost total erop failures and wheat rose in price to above 78s. Thus we see that imperial edict makes no difference, one way or the other, in comparison to the effects of crop conditions. An imperiai edict, so far from being an efficient cause of price change, is nothing more than a mere effect of the times, an incident to the conditions prevailing.

THE CYCLES.

That there are recurring cycles of movement in nearly all, if not, indeed, absolutely all natural phenomena, there is now no longer any reason able doubt. No scholar of the day, no scientist, no investigator of these times, would for a moment argue against this well established fact. The proof is not only complete and conclusive that nearly all phenomenal movement is in recurring cycles, but it has been shown that such movements are regular, smooth, symmetrical and harmonic. So certainly and so exactly is this the case that the scientists find it easy to graphically represent the motion by means of a simple algebraical expression, usually in the form of $Y = \cos x$. The ocean tides are com-puted by means of equations developed from this simple expression of relation in geometry. Fourier, Schuster, and others, have written books upon the subject, showing to absolute demonstration that nearly all cycles in nature are representable in terms of the cosine curves.

In fine, among the scientists of our time it is known that natural phenomenal cycles are almost always representable in composites of cosine curves superimposed upon each other through algebraical equations in the form of a y Fourier sequence.

The mathematical discussion of the harmonic cycles can not be attempted here, as it would-

icad into fields so broad as to be beyond the scope of a short essay on the wheat curve, but students who wish to go deeply into such matters may do so by the aid of the mathematical works published for that purpose.

It must suffice for me here to say that, since the changes in the price of wheat are due almost wholly to natural causes, the wheat market curve, when plotted on paper in the usual way, becomes a composite cosine curve, resolveable into its component parts by the application of the common harmonic analysis as used by the best scientists of our day in the work of investigating similar phenomena. Then, of course, as a necessary corellary to this, we may synthetically combine these harmonics, under correctly formulated and evaluated equations, thus projecting the curve to any desired extent into all inture dates desirable.

How this is to be done with regard to the wheat curve will be explained herein, but even without this explanation as regards the harmonics, the student will have no trouble in securing satisfactory results by means of the very simple devices given herein, as based upon such harmonic analysis.

FINDING THE CYCLES AND EPOCHS.

In looking for recurring cycles in the price movement of wheat the first requisite will be the diagramed, or charted, record. This is because a diagram or chart most readily lends itself to clear, comprehensive and open inspection. The long record of wheat prices as given herein is expressed in English shillings and pence, 12 pence being equal to one shilling. The calendar year is the unit of time. We then proceed, in the usual way, to chart the prices of the table, thereby producing the wheat curve, supe posed to be the representative curve of natural " phenomenal movement in prices, and, as such, must be a composite of cosine values spaced by cycles from points of epochs.

Referring, now, to this chart, we perceive, at about the first glance, that along near the year 1812 a very prominent and notable top appears. This will suit us very well as a starting point in our search for cycles, because it is in the modern times and is unmistakably a true top. Taking another glance on down the curve we notice that in the year 1322 there is a pretty stiff top and as it comes out some time back in the Middle Ages it ought to be far enough back to give us a few cycles in between. The difference between 1322 and 1812 is 490 years, and upon look-ing for other tops in between we come to find out there must be something like 8 to 12 of them, or, let us say, on the averagt, ten of them. sufficiently prominent as to merit more than ordinary attenion. Seeing this, the conclusion becomes irresistable that a cycle may be found just 49 years long, for 490 divided by 10 will be 49 years even.

This puts us in mind of the famous jubilee cycle of the ancient Jews, which was 49 years in length. We also call to mind that he Jew used a 7-year cycle, which is, of course, the 7th harmonic of the jubilee cycle of 49 years. Fur thermore, the ancient jubilee cycle had direct. reference to land values, crops, and undoubtedly the price of wheat, as a consequence. This is to be found in the 25th chapter of Leviticus. Upon gathering the idea that in this chart of the wheat curve there might be found a cycle of 49 years with its seventh harmonic superimposed upon it to represent the shorter swings which we see occur in the diagram, our next "step will be to make a test of the case.

In order, then, to settle somewhat more definitely just about what the 49-year cycle does contain in the way of shorter harmonics, we take the record out in sections of 49 years, beginning with the year 1812 as a starting point, or radical epoch. This plan will result in the record being cut up into short sections, that is. 49 year cycles, beginning with these years:

1273 1322 1371 1420 1469 1518 1567 1616 1665 1714 1763 1812 1861 1910 1959 2008 A well known process in statistical investigation is that of averaging, that is, algebraically adding together a considerable number of cycles in the record, all of the same length, in order to get their average value, because such average will fairly represent the cycle as measured from any of its epochs. Also, if there is a permanent harmonic within such cycls it will very likely appear as an harmonic component of the curve, all brought out by the process of averaging. Accordingly, I have worked out the averages for the 49-year cycle of the wheat record, using the epochs as just given.

I begin with that epoch which falls out at the year 1273, because it is eleven cycles back from the radical year 1812, which has been chosen for

reasons before mentioned. I then combine the six cycles following that year in order to form a composite, or average, which shall embrace the early part of our record. Now, because there is some question regarding a few years in the cycle from 1567 to 1616 I leave that period out of all the calculations and in the next table combine five more cycles in an average thus showing the movement for the latter part of our record, and also in what may be considered the modern times. By thus leaving out the central cycle (which, however, is quite regular and in no great amount different from all the others) we get two sets of averages, one of the early movements and one of the later movements of the prices of wheat.

The first set of averages was composed of the five cycles laying between the years 1273 and 1567. Then the cycle 1567 to 1616 was left out, and the second, or modern set is from 1616 to 1910. They prove to be very similar, so nearly so that I simply combine all together in order to form the 49-year cycle and derive from it the natural harmonic which evidently inheres within it. This result is given in the Composite Chart of the 49-year cycle and it is the one used as the basis of all forecasting.

If we examine the composite chart with some attention we will find that there are just about cight places where tops come out and likewise there are eight bottoms. Eight into 49 goes 6.125 times, so it seems very much as though the famous 7-year cycle of the ancient Jews was in reality about six and one-eighth years instead of 7. It is the eighth harmonic that gives the 4 best results in the 49-year cycle, instead of the seventh. This is easily seen when we come to lay this composite down on the record. In the record we have 13 complete cycles, beginning with the year 1273, and we find this composite falls in very well, though not perfectly, of course, in every one of them, and perfect conformity is hardly to be expected. There are irregularities in the record from several outside causes, and, furthermore, our averages may not be perfect, yet it is quite plain that even as we have them they would serve very well for forecasting purposes. It beats guessing at the problem, and, being strictly scientific, it is far and away superior to any other method yet de vised for reaching estimates as to the probable prices of wheat in future years.

In the chart of the composite page 26, notice that a top comes out at the 45th year, while absolute bottom is at the 24th year, thus showing that the curve for 49 years is not regular but runs smoothly down about 28 years and then rises 21 years and thus repeats indefinitely. This is because upon this smooth 49-year curve is fixed its eighth harmonic of 6.125 years, and if we assume that in the 45th year the true top is permanently located then upon going back six years each time we should have tops distributed in the whole cycle of 49 years nearly as follows: Maximums at 45, 39, 33, 27, 21, 15, 9, 2 and then 45 again and so on forever. We see by the chart of the averages that this is the distribution, yery nearly. To place the minimums we add 4 to the first one and 3 to every other maximum and it gives all the minimums very well in the following order, going back : Minimums are at 48, 42, 36, 30, 24, 18, 12, 6, then 48 and so on. Page 26. 14

It is true that the demonstration does not give perfect results, but they are so close that we would be in great error if we rejected them just because we could not get absolute apple-pic order out of them.

After a great number of trials and experiments I found that these figures as I give them, with the epochs as in the table, will afford the best criterion that we can derive for forecasting purposes. But in order to make them smooth and more available for forecasting, I have arranged the harmonics as in the Harmonic Chart and this Harmonic Chart will be considered as the final result and the one to be used in all projections into future years. Bottom page 26.

The Harmonic equations for this Harmonic Chart may be written as follows (but yet I arrange the harmonics to even dates instead of trying to adjust to fractions of the year.)

In this equation A is the 49-year cycle in the form of a cosine curve of 49 units, while B is its 8th harmonic, permanently superimposed, as the plus symbol indicates. The s means English shillings, or merely whole numbers. The t is time from the epoch counted in calendar years. Component A begins with the year 1273; B with 1269 The graphic solution of this equation is given in the dotted curve on page 26, and the numerical values are in the table on page 27, wherein is also shown the values for the record composite from which it is derived. Both are diagramed together on page 26. This harmonic is useed to form the long-swing forecast.

It is the scientific theory, and our adopted doctrinal, that the influences which cause variations in wheat prices proceed, in time, along a path which when plotted in the usual way on paper, is approximately a cosine curve. This table gives the yearly mean price of wheat in England. The rrices are shillings and tenths of a shilling instead of in pence. The change was made in order to secure Following are the parities 10 01 8 0 **5** ∞ greater facility in handling the values in analytical processes. 9 പ 4 ••• 2 When pence are.....

RECORD of the mean price of wheat in England each year from 1270 to 1909. Price is shillings and tenths of a shilling per English quarter of about 8.252 bushels.

\mathbf{x}		0	1	2	3	4	5	6	7	8	9
	127	6.4	10.0	6.4	5.5	6.8	5.1	6.3	5.2	4.5	5.1
	128	5.0	6.1	6.0	7.0	5.0	5.4	4.6	2.8	3.1	4.4
9	129	6.4	5.6	5.4	8.3	16.0	6.8	4.8	5.2	5.2	5.8
0	130	4.8	5.0	5.0	4.1	5.8	4.9	4.0	5.8	6.9	7.2
• • •	131	7.1	4.5	4.9	5.6	8.4	14.9	16.0	39.5	4.6	5.8
4	132	6.4	11.8	9.0	8.5	7.4	5.7	3.7	3.9	6.4	6.6
4	133	7.2	1.9	4.8	4.2	4.0	5.4	4.9	3.6	3.0	[5.9]
	154	3.1	3.8	4.2	0.1	3.5	3.8	6.9	6.6	4.2	5.5
**	150	8.3	10.5	1.2	4.5	D. 4	5.9	0.0	6.8	0.6	[5.9]
2	120	0.4	$ \frac{5.5}{7.0} $	$\frac{1.0}{7.8}$	0.0	1.0	0.0	0.0	0.1	0.4	11.9
_	138	63	5.6	5.3	1.8	5.6	5.1	4.0	-). U -2.1	27	0.0 5 4
	139	8.8	5.5	32	3.8	3.9	5.0	6.0	58	53	-0.4
•	140	7.9	7.5	6.8	4.9	4.0	3.8	4.4	4.6	7.3	9.0
:	141	4.9	4.8	4.9	4.3	4.4	6.4	8.0	5.4	7.0	4.8
S:	142	6.3	5.3	4.4	4.5	5.0	4.0	3.9	4.4	8.9	7.9
	143	5.9	4.7	6.9	5.8	5.5	5.5	5.4	9.4	14.7	7.7
te	144	3.9	4.0	3.9	4.2	4.0	6.4	6.0	5.2	5.7	5.4
tu	145	6.6	6.5	5.8	5.1	3.8	5.5	5.0	5.8	5.9	5.2
sti	146	7.0	7.4	4.4	3,9	4,2	4.6	5.4	5.5	5.7	6.5
i di	147	5,8	5.7	4,1	3,8	4,5	5.4	5.2	6.7	6,6	5.8
S	148	5.8	8.6	10.4	1,3	5.4	4.5	$[2, \frac{1}{2}]$	5,5	5.5	5,9
al	$149 \\ 150$	4.9	6,6	4.5	4.1	4.8	4,1	5,5	$[\frac{\partial}{\partial}, \frac{1}{\partial}]$	5.5	4.8
im	$100 \\ 151$	0, 2	ð.4 5 0	0.1	0.4	D.U 5 1	4.0	0.4 5 1	0.0	- 5,9 -6 0	3.0
ec	151	4.0	0.9	0.1 6 0	5.5	0.4 5 9	0.0 5.1	0.4	0.0 19 0	0.0	8.0
D	152	84	8 2	8.0	77	$\frac{3.2}{7.0}$	10.1	10.7	$\frac{12.0}{7.1}$	6.0	-0, 8 -5 G
'n€	154	5.8	9.0	79	9.3	90	15.6	8.3	49	8.2	16.4
-	155	18.0	20.4	10.6	10.0	18.8	22.1	28.5	8.5	9.3	11.1
	156	14.3	15.7	10.9	19.8	10.9	10,6	16.4	11.1	11.4	11.8
	157	9.8	12.1	13.6	26.4	14.4	15,9	22, 3	20,2	17.4	17.5
	158	20,0	20,1	19,2	22.0	24.0	17.0	7.5	18.0	14,3	15.0
	159	16,2	17.4	18.6	20,0	56,0	53,0	80.09	92.0	56.7	39,0

Record of wheat-Continued.

İ		0	1	2	3	4	5	6	7	8	9	j è
i	$\frac{-}{160}$	36.7	$\overline{34.9}$	$\overline{29.4}$	$\frac{-}{35.4}$	30.7	35.9	33.9	36.7	56.7	50.0	
	161	35.9	38.7	42.4	48.7	41.8	38.7	40.4	48.7	46.7	35.4	<u> </u>
	162	30.4	30.4	58.7	52.0	48.0	52.0	49.4	3 6. 0	28.0	42.0	l c
	163	55.7	68.0	53.4	58.0	56.0	56.0	56.7	53.0	57.4	44.9	
ł	164	44.7	48.0	68.0	67.0	70.0	<u>69.0</u>	48.0	73.7	85.0	80.0	Ŭ
	165	76.6	73.4	49.5	35.5	26.7	33.4	43.0	46.7	65.0	66.0	a
	166	56.5	10.0	14.0	57.0	40.5	49.4	36.0	36.0	$\frac{10.0}{10.0}$	44.4	la
ł	167	41.7	42.0	41.0	46.1	68.7	64.1	38.0	42.0	59.0	50.0	j
	168	40.0	40.1 21 0	44.0	40.0	44.U 64 0	40. 1 52 A	34.0 71.0	20.2 60.0	40.0	30.0 64 0	Or
	109	9 4. (40-0	94.U 37 7	±0.1 20 万	26 0	16 5	20 0	26 0	28 5	11.5	04.0 78 5	_
I	171	$\frac{40.0}{78.0}$	54 0	$\frac{29,9}{46}$	50.0 51.0	50.9	43.0	$\frac{20.0}{48}$ 0	45.0	$\frac{11.0}{38.8}$	35 0	n
I	172	37.0	37.5	36.0	34.7	37.0	48.5	$\frac{1000}{460}$	$\frac{10.1}{42.0}$	54.5	16.8	ne
ł	173	36.5	32.8	26.7	28.4	38.9	43.0	40.4	38.0	35.5	38.0	ත
ł	174	50.7	46.7	34.0	24.9	24.9	27.5	$\overline{39.0}$	34.9	37.0	37.0	JI
l	175	32.5	38.5	41,9	44.7	34.7	33,9	45.3	60.0	50.0	39.9	er
l	176	36,5	30,3	39,0	40.8	46.8	54,0	48.5	53, 2	60.2	45.5	
İ	177	49.0	47.2	50.7	51.0	52.7	48.4	38.2	45.5	42.0	33.7	<u> </u>
İ	178	35,7	44.7	47.8	52.7	18.8	51,8	38.8	41,2	45.0	51.2	Je
	179	54.8	48.6	43.0	49,3	52.3	75,2	78.6	53.8	51.8	59.0	
ł	180	\$3.8	29.5	69.8	58.8	52, 3	89.7	79.1	75.4	81.49	97.4	Ď
l	181	46.5	95.3	¢2.5	19.8 - 9	(4.4)	65,6	18.5	96.9	86,3	(4.5)	<u> </u>
I	182	67.8	56.1	44.6	53,40	55.9	58.5	58.7	58.5	60.4 CA	56.3	20 20
l	104	04.5	00.4	98.78 57 9	92,9° 50 1	$\frac{1}{20}, \frac{2}{20}$	39,40 30,40	48.06	50.8	04.0 50.5	10,7	Ö
	104	00, 4	04.40	10.8	50.18 52 20	91.0 79 1	50.0	04. 13 60 9	58.0 58.1	90,9° 1.1-9	±4.0 12 Q	[]
	186	52.2	55.0	55 1	11 8	10.4 10.2	11, 1 11, 8	19.9	30.4° 34.4	11.2° 63.9	±シ, 0 (ミッ)	010
	187	46.9	56.7	57.0	58.7	55.8	45.2	46.2	56.8	46.1	$\frac{13}{13}$	e e
	188	14.4	45.4	16.8	41.6	35.7	32.9	31.0^{1}	32.5	32.5	29.7	0
l	189	31.9	37.0	30.3	26, 4	22.9	23.1	26.2	30.2	34.0	25.7	ar
	190	26.9	26.1	28.1	26.8:	28.4	29,7	28.3	30.6	32.0	36,9	G
	1	For	year	· 180	0 pi	rice	is 1	113.8	; 18	01 1	19.5:	sn
1	811	106.	5; 1	812	126.5	5; 18	313-1	09.8			,	ea

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The Monthly Swings in Wheat Prices.

The record for the monthly swings in wheat prices for each calendar month of every year from 1844 to present date is given in the Monthly Chart. It is of the mean monthly price of wheat, found by adding together the highest and the lowest price made during the month and dividing the sum by two.

The record used for making the Monthly

Chart is the Cincinnati price for cash wheat from 1844 to 1857, and from 1858 to present it is the Chicago market price for cash wheat. I give this Monthly Chart in six sections of years each, because after much careful experi-ment I found that there is a period of just 13 years in which the monthly mean price passes through a complete cycle of change.

By adding together the five cycles of the rec-ord, beginning with the years 1844, 1857, 1870, 1883 and 1896, I derived a composite, or mean curve 13 years long, and it is supposed to be the regular forecast for any 13 year cycle, past or future, if taken from dates of epochs as given licrein. This cycle I have diagramed along with the record charts, in order to show how well it works as a forecast. It is also projected into future years to serve as a guide for forecasting. For future dates the new 13-year cycle will begin with the years 1922, 1935, 1948, 1961, etc.

All modern statisticians are familiar with this method of deriving a curve for forecasting purposes and it is now considered to be strictly scientific method. But the use of it is easily tested by trying it upon the record, as I have done in the Monthly Charts, where, by mere in-spection we may judge quite closely as to its merits and demerits as a forecast.

Upon making the comparisons as suggested we find that the main features of this 13-year cycle, or composite, are a fairly general regularity for the first five years of it, for in those years we see tops come out in May or June, after which a heavy decline occurs, but with a rally at about the end of the year. In the sixth year the tops come in September. The ninth year appears to be a sort of transition year and it is therefore the least reliable of all, but yet there are generally two tops in it, one coming pretty early and one pretty late.

If a trader would stay on the long side up to about May in the first five years of this cyclt and then sell out and go short to near the end of harvest he is likely to gain. In the sixth year, however, he looks out for the market to run on to after harvest before dropping much, and then a rally again early in the 7th year, and so on, going pretty well by the number of the year in the 13-year cycle, yet paying attention, also, to the long-swing cycle of 49 years with its harmonic of 6.125 years.

In fine, the general plan of forecasting is to assume that the price of wheat generally will be about as forecasted in the 49-year cycle, but yet the monthly movements should be attended to as forecasted by the 13-year cycle.

It is beyond the scope of this work to give the methods of forecasting the daily prices, but the student may study the movements along the lines herein suggested and he should finally succeed much better than by any other known method, and away better than by mere guessing

It is of course to be understood that the student and investigator will make up his own charts and work out his own figures, following the guidance herein offered.

THE MONTHLY CHARTS.

The monthly charts from 1844 to 1921 inclusive are not draws to scale, as it would require a very large engraving to give so many months to actual scale. But yet the actual movement of prices is given relatively in every year.

) The years, in three sections on each page of the monthly charts, with the dates given, are the record movements, while the lowermost section on each page of the monthly charts, with figures from I to I3, is the curve of the composite of the five I3-year cycles lying between 1844 and 1908 inclusive. Carefully notice that this composite, the figures for which are given in a table, serve as a true forecast for all years after 1908, because the record after 1908 is not worked into the composite.

Note that for every year after 1908 the forecast is pretty fair, except in the case of 1916-17 which was during war conditions. The Government controlled prices from Sept. 7, 1917, to June 1, 1920, yet even at that the forecast (the bottom curve in the monthly charts) is fair.

The Forecast.

It is, of course, perfectly plain to every reader that the composite curve at the bottom of each monthly chart in the 13-year cycle is the forecast for all time after January, 1009. But in order to make it so clear that no sort of mistake can be made regarding the use of the cycle as given, I give here the years in the future that correspond with the numbered years in it:

0	1	2	
4	L	J	

Table of Epochs in the 13-year Cycle.

1 2	3	4	5	6	~ 7	8	9	10	11	12	13
$\begin{array}{r} 1909 \ 1910 \\ 1922 \ 1923 \\ 1935 \ 1936 \\ 1948 \ 1949 \end{array}$	$1911 \\ 1924 \\ 1937 \\ 1937 \\ 1950 \\ 1$	912 925 938 951	1913 1926 1939 1952	1914 1927 1940 1953	$1915 \\ 1928 \\ 1941 \\ 1954$	$1916 \\ 1929 \\ 1942 \\ 1955$	$1917 \\ 1930 \\ 1943 \\ 1956$	$1918 \\1931 \\1944 \\1957$	1919 1932 1945 1958	1920 1933 1946 1959	$ 1921 \\ 1934 \\ 1947 \\ 1969 $

Example—Let it be required that we furnish a forecast of the price of wheat for the calendar year 1925.

We first refer to the 49-year cycle and find that the year 1925 will be the 16th year in the 49-year cycle, and as a consequence we will find, upon examining that cycle as per the chart of it at the bottom and right side of page 26, that prices are on a swift decline and nearing bottom at the end of the year. We also see this in the figures of the composite as shown in the table.

Next, we go into the table of epochs for the 13-year cycle as given above, and find that it will be the 4th year of it. Then referring to No. 4 of the 13-year cycle chart, or the table, we find prices strong to February, break down some in March, but go to a top about in June, followed by a swift drop to November, but with a rally up in December and January of the next year. In this manner we get out the forecast for a w number of years in advance that may be desired.

Still furthermore, in order to render it perfectly easy to handle the monthly values in the 13-year composite, I give the table complete, as, reduced from my original values found by the process of averaging, as described before. This, table furnishes the monthly forecasts for all future years, measured from the epochs as above.

Table of the 13-year Cycle.

These figures are charted, pages 27 and 28. They are the values to use for forecasting purposes, superimposed upon the 49-year cycle, as has been explained.

1 10				Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
and and and and and and and and and and	1922	1st	year	8	17	11	20	40	36	25	14	5	0	11	9
	1923	2	6.6	15	20	17	15	25	27	0	14	16	10	17	22
4	1924	3	6.6	23	26	28	32	38	20	8	0	5	15	18	20
	1925	4	6.6	22	30	17	30	3 6	44	25	23	12	10	9	23
	1926	5	66	27	20	31	35	40	25	10	5	7	5	0	3
	1927	6	66	9	7	14	16	20	18	31	36	40	34	25	21
	1928	7	66	26	36	38	26	23	21	20	0	15	22	18	27
	1929	8	6.6	24	15	6	25	40	38	35	34	20	14	16	9
	1930	9	6.6	16	15	13	10	5	-0	5	18	22	17	13	9
	1931	10	66	11	15	18	4	20	34	22	6	15	27	36	38
	1932	11	6.6	22	27	20	32	44	25	9	11	15	3	10	18
	1933	12	66	21	25	32	40	35	39	10	21	16	33	37	31
	1934	13	6.6	36	20	17	6	21	36	30	20	12	4	0	7

Concluding Remarks.

On page 27 is given the table of composite and harmonic values in the 49-year cycle. That composite is, as before stated, the result of eleven cycles added together, while the harmonic values are merely the smoothed curve of this same composite, and both are charted together on page 26. As a scientific principle we assume that the harmonic will give best results in forecasting, but of course the composite might be adhered to if the student prefers the natural composite. The range given in this booklet is arbitrarily 36, as there appeared to be no necessity for using larger figures, but any experimenter may easily change the range to suit his own purpose.

No true harmonic for the 13-year cycle was worked out, although it is just possible that a useful harmonic might be found in it when longer records become available in later years. It seems probable that 13 years is not of itself a true cycle, the real cycle being $49 \div 4 = 12,125$ yrs. But a rather singular thing is that the period seems to contain just 13 even units, that is, calendar years, so that the fraction actually counts as a year, in the present era. That is, it seems as though there were but 13 different kinds of movement in the years, and even these are generally upward from October to May and then down to October again. This is indicated by the first five years.

MONTHLY RECORD CHICAGO WHEAT

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Year	and a	The
184 184	4 75	77	75	75	$\frac{69}{74}$	$\frac{60}{75}$	59 62	$\frac{68}{53}$	70	66	$\frac{70}{75}$	70	6 9 70	for	Start.
184	6 75	73	80	65	56	50	45	$\frac{00}{48}$	$52 \\ 52$	63	68	-50 - 58	60	ec	in-
184	7 62	80	75	87	92	105	75	73	75	84	86	102	83	as	
	$\frac{94}{5}$	8.3	90	90	88	75	-62	64	75	74	75	75	78	t f	nd .
$184 \\ 185$		10	10	69	71	170	80	81	86	83	10	80	78	10	ic
185	$5 50 \\ 1 76$	72	67	- 9 9 71	70	$\frac{110}{70}$	00 64	-10 -69	59	59	-08 -58	10	-86 -66		e
185	2 59	59	62	62	61	63	62	59	60	60	66	75	62	h	m
185	8 80	77	75	75	74	84	80	80	88	96	104	102	89	ica	VV(
1854	4114	133	125	$131 \\ 100$	160	141	104	131	142	132	146	158	134	50 C	en
1808	0 160 3 141	$163 \\ 121$	$167 \\ 116$	$192 \\ 110$	192. 119	174	$\frac{112}{102}$	125	122	148	167	156	156	0	nej
1000 185'	$\frac{141}{114}$	$101 \\ 115$	$110 \\ 112$	110	$112 \\ 140$	140	102 197		113. 80	116.	110 80	111. 179 -	114	W	nt
1858	3 256	55	$\frac{112}{62}$	63	$\frac{110}{62}$	67	$\frac{12}{64}$	87	$\frac{09}{76}$	66	61	#10. 65	71	ne	S
1859	81	87	92	83	104	83	63	61	73	80	86	93	83	at	SB
1860) 98	99	101	105	106	103	99	84	86	82	78	74	90	5	H.
1861	$ 76 \\ 07$	75	78	95	108	64	61	71	67	71	66	65	84	7	ct.
1802 186		109	108	$\frac{12}{109}$	40	72	81	86	81	86	11	84	77)r(hi
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1865	141	124	115	103	105	1061	108	120^{-1}	124	23	22	931	18	00	à
1866	84	82	92	96]	117]	1201	106	139	1791	861	891	871	36	Le(ole
1867	145	190	207	2432	267 2	207]	188	173]	177 1	.891	77]	.80 2	06		0
1868	149	$\frac{200}{110}$	196	2022	200]	98]	95]	[74]	154 1	.261	121	.001	51	0	lre
1870	114	110	$\frac{112}{77}$	108 I 84 I		101	171	[37]	1231	.06	89	851	12	th	O
1871	120	125	126^{-1}	1271	28	291	$\frac{1}{201}$	121	991 201	181	.05 I 20 I	00 101	92 20	ē	ha
1872	$\overline{123}$	125	117	1281	481	381	$\frac{1}{261}$	[36]	$\frac{201}{231}$	141	$\frac{201}{061}$	161	$\frac{20}{28}$	Уе	rt
1873	123	124	120	1191	281	231	201	321	051	021	.001	121	$1\check{6}$	à	ed
1874	122	119	120	1241	231	201	131	.02	98	92	88	90 1	06		0
1876	89	86	92	99	98	961	201	231	.121	101	.09	991	04	.96	n
1877	127	102	1021 1251	1501	591	.00 48 1	94 201	901	121	101	121	201	05	52	0a
1878	105	106	1081	091	$.06^{1}$	$\frac{10}{94}$	99	98	$\frac{121}{88}$	101 83	83	001 84	0 <u>4</u>	C	10
1879	84	90	92	87	971	04	96	86	961	131	16 1	291	07		Nr

[‡] The Cincinnati record ends Dec. 1857, and Chicagə record begins Jan. 1858. Prices are mean of the month.

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MONTHLY RECORD CHICAGO WHEAT

an		Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Year
The y d a f	${1880}$ 1881	$\overline{123} \\ 93 \\ 120$	$\overline{\begin{array}{c}122\\98\\124\end{array}}$	$\frac{119}{101}$	$\overline{\frac{110}{103}}$	$116 \\ 107 \\ 196$	95 111 120	$92 \\ 116 \\ 121$	$\frac{88}{129}$	$92 \\ 131 \\ 102$	$\overline{\begin{array}{c}97\\137\\05\end{array}}$	$\overline{\begin{array}{c}107\\128\\02\end{array}}$	$102 \\ 127 \\ 02$	$106 \\ 115 \\ 116$
rearl	$ 1882 \\ 1883 \\ 1884 $	$ \begin{array}{r} 130 \\ 98 \\ 92 \end{array} $	$124 \\ 108 \\ 94$	$ \begin{array}{r} 129 \\ 107 \\ 87 \\ \end{array} $	131 106 85	$ \begin{array}{c} 120\\ 111\\ 90 \end{array} $	$130 \\ 106 \\ 87$	$131 \\ 100 \\ 82$	103 102 80	102 96 77	95 93 72	95 95 73	92 97 72	$ 102 \\ 83 $
y pri	$1885 \\ 1886 \\ 1887$	$79 \\ 81 \\ 79$	$77 \\ 80 \\ 75$	$\begin{array}{c} 76 \\ 78 \\ 76 \end{array}$	85 77 80	$\begin{array}{c} 88\\76\\85\end{array}$	87 74 80	88 76 70		82 76 69	88 72 71	$ \begin{array}{c} 90 \\ 75 \\ 74 \end{array} $	86 78 77	82 77 76
ce m or Ch	$1888 \\ 1889 \\ 1890$	77 97 76	$75 \\ 101 \\ 75$	$74\\100\\79$	76 89 84	85 82 96	82 79 89	82 81 90	88 77 99	$127 \\ 79 \\ 100$	110 80 99	$ \begin{array}{r} 109 \\ 80 \\ 95 \end{array} $	$102 \\ 78 \\ 91$	$\frac{101}{89}$
oven	$1891 \\ 1892 \\ 1000$	92 87	95 88	$ \begin{array}{c} 99 \\ 84 \\ 76 \end{array} $	107 81 50	$ 104 \\ 83 \\ 72 $	97 83 65	90 78 60	100 77 50	$ \begin{array}{c} 95 \\ 73 \\ 66 \end{array} $	$ 96 \\ 72 \\ 62$	94 71 61	92 71 62	99 80 70
ients o whe	$1893 \\ 1894 \\ 1895$	$ \begin{array}{c} 75 \\ 61 \\ 51 \end{array} $	57 50 50	58 54 54		56 71 72 7	57 57 75	55 66	$\begin{array}{c c} 59\\ 54\\ 64\\ 54\end{array}$	53 59	$\begin{vmatrix} 0.5 \\ 51 \\ 60 \\ 50 \end{vmatrix}$	54 57	55 56	
as in eat is	$ 1896 \\ 1897 \\ 1898 $	$ \begin{array}{c} 62 \\ 77 \\ 99 \end{array} $	$\begin{array}{c} 66 \\ 75 \\ 102 \end{array}$	$ \begin{array}{r} 65 \\ 74 \\ 103 \end{array} $	66 72 112		50 70 95	58 74 77	58 88 70	63 93 67	90 66	85 92 67	84 96 66	$\begin{array}{c} & 1 \\ & 83 \\ 109 \end{array}$
this	$ \begin{array}{c} 1899 \\ 1900 \\ 1901 \end{array} $	$\begin{array}{ }72\\64\\74\end{array}$	$\begin{array}{c c} 72\\ 66\\ 73 \end{array}$	$\begin{array}{c c} 70\\ 65\\ 75\end{array}$	$\begin{array}{c c} 73\\66\\72\end{array}$	$\begin{array}{c c} 74\\ 66\\ 73 \end{array}$	75 77 71	$\begin{array}{c} 72 \\ 78 \\ 67 \end{array}$	72 74 71	73 76 75	$\begin{array}{c c} 12\\ 74\\ 69\end{array}$	68 72 71	66 72 76	$\begin{array}{c} 71\\71\\73\end{array}$
table	1902 1903 1904	77 75 87	$ \begin{array}{c c} 75 \\ 77 \\ 98 \end{array} $	73 73 96	$\begin{array}{ c c } 74 \\ 75 \\ 94 \end{array}$	75 78 97	$74\\80\\104$	$\begin{array}{c} 75 \\ 79 \\ 103 \end{array}$	$72\\84\\107$	83 84 114	$\begin{array}{c} 73 \\ 82 \\ 116 \end{array}$	$74\\81\\115$	$75\\82\\114$	$\begin{array}{c} 77 \\ 79 \\ 102 \end{array}$
e are d to t	1905 1906 1907	118 86 73	$ \begin{array}{r} 119 \\ 83 \\ 80 \end{array} $	$ \begin{array}{r} 115 \\ 80 \\ 79 \end{array} $	$\begin{array}{c}103\\85\\81\end{array}$	$ \begin{array}{r} 100 \\ 88 \\ 93 \end{array} $	107 86 96	$\begin{array}{r}103\\79\\98\end{array}$	97 70 94	86 74 97	$\begin{array}{r} 87 \\ 72 \\ 107 \end{array}$	188 73 93	$\frac{86}{74}$ 102	$\begin{array}{c}103\\79\\90\end{array}$
chart the y	1908 1908 1909	97 107	94 116	$100 \\ 120 \\ 110$	$98 \\ 132 \\ 114$	$105 \\ 140 \\ 110$	$100 \\ 144 \\ 106$	$102 \\ 123 \\ 114$	$107 \\ 118 \\ 115$	$101 \\ 108 \\ 106$	$103 \\ 113 \\ 103$	$115 \\ 112 \\ 99$	$ \begin{array}{c} 108 \\ 117 \\ 100 \end{array} $	$\frac{105}{126}$
ced on ear 1	1910 1911 1912	$102 \\ 103 \\ 103$	97 105	$ \begin{array}{c} 113 \\ 93 \\ 107 \\ 07 \end{array} $	94 111 100	98 116 100	95 113 00	$ \begin{array}{c} 96 \\ 107 \\ 90 \end{array} $	101 101 80	$ \begin{array}{c} 100 \\ 99 \\ 92 \end{array} $	106 101 01	$ \begin{array}{r} 102 \\ 96 \\ 53 \end{array} $	101 98 94	$\frac{100}{106}$
n pag 962.	$ \begin{array}{r} 1913 \\ 1914 \\ 1915 \end{array} $	$102 \\ 93 \\ 140$	$ \begin{array}{r} 101\\ 94\\ 157 \end{array} $	$\frac{97}{93}$ 151	$ \begin{array}{r} 100 \\ 93 \\ 158 \\ 100 \end{array} $	$ 100 \\ 96 \\ 149 \\ 110 $	99 89 130	$ \begin{array}{r} 90 \\ 94 \\ 132 \\ 118 \end{array} $	$106 \\ 120 \\ 142 $	$ \begin{array}{r} 52 \\ 117 \\ 109 \\ 156 \end{array} $	110 110 170	$115 \\ 109 \\ 182$	$122 \\ 117 \\ 166$	$106 \\ 133 \\ 146$
e 26	$ \begin{array}{r} 1916 \\ 1917 \\ 1918 \end{array} $	$129 \\ 185 \\ 218$	$124 \\ 178 \\ 218$	$\frac{114}{193}$ 218	$122 \\ 200 \\ 218$	$ \frac{110}{301} 218 $	$108 \\ 267 \\ 218 $	118 255 227	$143 \\ 256 \\ 228 \\ 200 $	$150 \\ 224 \\ 226 \\ 226$	$\frac{119}{218}$ $\frac{225}{225}$	$103 \\ 218 \\ 226 \\ 959$	100 218 232	240 224 224
3	$ \begin{array}{r} 1919 \\ 1920 \\ 1921 \end{array} $	$234 \\ 300 \\ 186$	$229 \\ 254 \\ 178$	$240 \\ 262 \\ 168$	$266 \\ 284 \\ 141$	$262 \\ 313 \\ 162$	$239 \\ 293 \\ 154$	$245 \\ 264 \\ 149$	$239 \\ 252 \\ 135$	$353 \\ 254 \\ 143$	$249 \\ 217 \\ 126$	$ \begin{array}{c} 2 & 13 \\ 191 \\ 117 \end{array} $	$294 \\ 186 \\ 123$	$262 \\ 250 \\ 155$
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MONTHLY RECORD

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